

NUCLEAR THERMAL PROPULSION

TECHNOLOGY

NTP Focused Technology Status Innovative Technology

- Model Development: Graduate Research
- Vapor-Core Modeling & Experiments: INSPI
- Gas-Core Simulation Facility: LeRC
- PBR Stability Modeling: MIT
- PBR Materials Modeling: Univ. New Mexico

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NTP Focused Technology Status Enabling Technology

- NOZZLES
 - CFD Model Development (3-D Navier-Stokes): LeRC
 - Nozzle Alternatives & Optimization Experiments: LeRC
 - Molecular CFD Plume Model Development: LeRC
- THURBOPUMPS
 - Low-NPSH Pumping Technology: MSFC
 - Materials Evaluation: MSFC
 - 3-D Navier-Stokes CFD Model Development: LeRC
- STRUCTURES
 - Probabilistic Model Development: LeRC
- INSTRUMENTATION & CONTROLS
 - High-Temperature Sensors: LeRC
- MATERIALS
 - Preliminary Sample Prep & Expts: LeRC & MSFC

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Non-nuclear Material

- Goal is usable materials database
- Results needed early to support design and analysis work
- Advanced and commercially available materials to be studied
- Develop required processing and characterization facilities
- Tie-in with Base R & T work

Instrumentation, Controls, and Health Monitoring

- Large advances since NERVA, needed for autonomous ops
- Details of overall system architecture TBD
- Plan to build off on-going efforts in chemical engine area
- Current LeRC effort concentrating on sensors
- Good progress to date with SiC

Turbopumps

- LeRC working flow and performance modeling
 - Evaluation and modification of existing codes
 - Will use TPA testbed to validate model
- MSFC working hardware specifics
 - Evaluation of concept options, materials, technologies
- Bearing options being studied

Nozzle and Extension

- CFD modeling of internal flow
 - Fluid, thermal, chemical behavior
 - 2-D work done for various temp and thrust ranges
 - Plan to expand results to 3-D, other nozzle forms



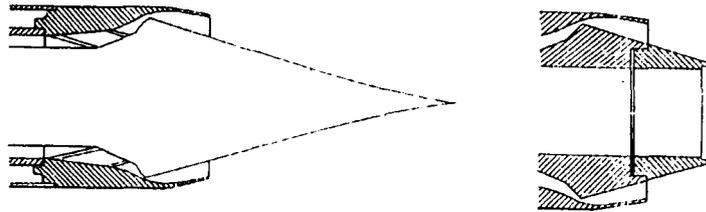
Mach Number Contours of a Reference Nozzle



Static Temperature Contours of a Reference Nozzle

Nozzle and Extension

- Alternative nozzle design evaluation
 - Study of various alternative nozzle forms
 - Goal is performance and packaging improvements
 - Small scale tests to take place in mid 93
 - Promising results flowed back into CFD effort



Nozzle and Extension

- Probabilistic Structural Modeling
 - Large Expansion ratio nozzles (>200:1) cannot be ground tested
 - Develop analytical ability to be able to launch with assured reliability
 - Apply available prob struct modeling methods to NTR nozzle
 - Input CFD results, fabrication process uncertainties
 - Develop probabilistic QA criterion
 - Develop design spec for nozzle and extension

Exhaust Plume Characterization

- Content and behavior of exhaust plume critical to man-ratability
- LeRC developing validated numerical simulation capability
 - CFD not sufficient
 - DSMC with finite difference Boltzmann techniques
- Will accomodate various nozzle shapes, species, conditions
 - Experimental validation planned

Summary

- NTP is key to SEI
- Non-nuclear technologies vital to NTP
- Critical technologies identified
- Work begun, preliminary results available
- Efforts will continue in an evolutionary manner